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PLIOCENE VIVIPARUS-LIKE OPERCULA FROM CALIFORNIA¹

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In 1924 Hanna and Gaylord² described as *Scalex petrolia* gastropod opercula that are confined to a thin layer in nonmarine beds lying between marine beds in the Etchegoin formation, of Pliocene age, penetrated by wells in the Elk Hills oil field and the adjoining Sunset-Midway field, at the south end of the San Joaquin Valley of California. These fossils, which are used to great advantage as guide fossils by the oil operators, will be described and figured in a report on the Elk Hills field now in preparation by the United States Geological Survey, but it seems desirable to put on record certain conclusions with regard to their generic relations. At the time when they were described no shells that were large enough for opercula of this size had been found, and Hanna and Gaylord suggested that they represent a chitinous-shelled or shell-less gastropod, probably of the family Amnicolidae, subfamily Bithyninae.

These opercula have a "length," measured along the longest diameter, of 6.2 to 8.7 millimeters and a "width" of 4.5 to 7

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²Hanna, G. D., and Gaylord, E. G., Description of a new genus and species of freshwater mollusks (*Scalex petrolia*) from the Etchegoin Pliocene of California: California Acad. Sci. Proc., ser. 4, vol. 13, pp. 147-149, 2 figs., 1924.

millimeters. They are composed of very thin calcareous laminae that are very fragile and peel off. The exterior surface is concave and the interior surface is convex. The nucleus lies close to the columellar side and concentric lines encircle it. On the interior surface a narrow thickened ridge lies between the columellar edge and the area where the foot was attached.

Fresh-water fossils, consisting principally of *Amnicola* and fresh-water ostracods, are the only fossils in the beds carrying the thin layer containing *Scalez petroliola*. Therefore it can be assumed that these opercula represent gastropods that lived in streams or lakes. It is apparent that the fossils are very similar to *Viviparus* opercula, despite the fact that all living species of *Viviparus* have horny opercula. The nucleus of the fossils lies closer to the columellar edge and the fossils are a little less than half as large as opercula of adult specimens of *Viviparus* living in eastern United States. No native species of *Viviparus* are now living west of the Rocky Mountains. An Eocene species has been described from Washington and a Miocene species from Nevada, but apparently the genus has not been discovered in late Tertiary deposits on the Pacific coast. Several species have been described from the late Cretaceous and early Tertiary deposits of the Rocky Mountain region. The opercula of these fossil species are not known. *Scalez petroliola* also resembles opercula of the genus *Ampullaria*, especially of the exotic species that have calcareous opercula, but the fossils are much smaller, thinner, and less elongate and fail to show the deep groove along the outer edge of the area where the foot was attached. The geographic distribution of *Ampullaria* also affords evidence that *Scalez* is not an *Ampullaria*-like mollusk, as it is not probable that a characteristically tropical genus lived in central California during Pliocene time.

After these fossils were described Doctor Hanna discovered a few broken shells that seem to represent the shell of the animal, and I am indebted to him for a core containing several broken, crushed shells. They are very thin and imperforate, and are marked by fine, but conspicuous, growth lines. At the aperture the body whorl has a height of 8.5 to 11 millimeters, but all the shells are flattened and the height is a little exaggerated.

So far as these crushed pieces go, they are very much like shells of a relatively small *Viviparus*.

The opercula and the less satisfactory crushed shells indicate that these fossils, to which the rather unfortunate generic name *Scalez* was given, represent an extinct group of Viviparidae that had calcareous opercula, although all living representatives of the family have horny opercula, and no other fossil Viviparidae having calcareous opercula have been found. Other families, such as the Naticidae, Ampullariidae and Amnicolidae, embrace genera with horny opercula and also genera with calcareous opercula.

So far these opercula have been found only in cores of cuttings, but it is safe to predict that they will eventually be found at the outcrop of nonmarine beds of Etchegoin age. Their remarkably limited stratigraphic range, on which their value to the oil operator depends, is more probably due to the absence of other nonmarine beds in the upper part of the Etchegoin formation in the Sunset-Midway and Elk Hills fields than to their actual sudden appearance and disappearance. It would not be surprising to find them in other wedges of nonmarine Etchegoin deposits.

NOTES ON THE NAIADES OF THE UPPER MISSISSIPPI DRAINAGE:

III. On the Relation of Temperature to the Rhythmical Contractions of the "Mantle Flaps" in *Lampsilis ventricosa* (Barnes)

BY N. M. GRIER

Ortmann (Mem. Carnegie Museum 4: 319, 1911) first described the rhythmical wave-like contractions of the lamellae and flaps of the mantle in the gravid female of *Lampsilis ventricosa*. His account includes a description of the position of the shell during the process. The animal orientates itself so that its anterior end is against the current, while the shell is so tilted that the animal almost "stands upon its head". The "mantle flaps", which are ribbon-like prolongations of the lamellar portions of the mantle, are slowly protruded as the creature opens